



# **Drug Abuse Prevention Training: Feasibility of Electrophysiological Assessment**

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# REPORT DOCUMENTATION PAGE

Form Approved  
OMB No. 0704-0188

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1. AGENCY USE ONLY (Leave blank)		2. REPORT DATE December 1997		3. REPORT TYPE AND DATE COVERED Final	
4. TITLE AND SUBTITLE Drug Abuse Prevention Training: Feasibility of Electrophysiological Assessment				5. FUNDING NUMBERS Program Element: 0305889N Work Unit: R2143	
6. AUTHOR(S) Gregory W. Lewis, David L. Ryan-Jones					
7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES) Navy Personnel Research and Development Center 53335 Ryne Road San Diego, California 92152-7250				8. PERFORMING ORGANIZATION AGENCY REPORT NUMBER NPRDC-TN-98-5	
9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES) Bureau of Naval Personnel (PERS-63) 2 Navy Annex Washington, DC 20370-0000					
11. SUPPLEMENTARY NOTES Functional Area: Training Research Product Line: Classroom and Afloat Training Effort: Drug Abuse Prevention					
12a. DISTRIBUTION/AVAILABILITY STATEMENT Approved for public release; distribution is unlimited.				12B. DISTRIBUTION CODE A	
13. ABSTRACT (Maximum 200 words) Evaluating attention to, and interest in, training materials depends primarily on voluntary verbal and written feedback from individuals, usually in the form of questionnaires or tests. The objective of this report is to describe research, which would determine the feasibility of using electrophysiological methods to assess the effectiveness of drug abuse prevention training. Drug abuse prevention videotapes were evaluated using irrelevant auditory probes to generate event-related brain potentials (ERPS) from the scalp frontal regions of 26 individuals. The subjects were divided equally into two interest groups (HIGH vs. LOW) based on questionnaire factor analysis scores. When prevideo baselines for the HIGH and LOW groups were compared, no differences were found. Statistically reliable differences were found between prevideo baseline and video segments for the ERP. The current research suggests that using auditory "irrelevant" probe stimuli, and the resulting ERP records, may provide an unobtrusive and objective measure of information, which may not be available through traditional behavioral measures. It is expected that with further development, "early" ERP components would improve the development and assessment of the effectiveness of education and training materials.					
13. SUBJECT TERMS Drug abuse training, personnel performance, personnel assessment, training assessment, electrophysiology, program evaluation, prevention training evaluation				15. NUMBER OF PAGES 53	
				16. PRICE CODE	
17. SECURITY CLASSIFICATION OF REPORT UNCLASSIFIED	18. SECURITY CLASSIFICATION OF THIS PAGE UNCLASSIFIED	19. SECURITY CLASSIFICATION OF ABSTRACT UNCLASSIFIED	20. LIMITATION OF ABSTRACT UNLIMITED		

NSN 7540-01-280-5500

Standard Form 298 (Rev. 2-89)  
Prescribed by ANSI Std. Z39-18  
298-102

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## Foreword

This report describes the work that this Center performed during FY93 and FY94. The reimbursable funding was provided by the Bureau of Naval Personnel, PERS-63, (Project R2143, Program Element 0305889N, Subproject DR002, titled, "Electrophysiological Assessment of Drug Abuse Prevention Training." The Program Manager was Dr. David Blank, (PERS-63E).

Several individuals provided substantial input to this project. They include CDR Tom Mattax, LCDR Rich McLaughlin, Mr. John Schultz, U.S. Navy Drug and Alcohol Program Management Activity (DAPMA), Senior Chief Winchell, Family Advocacy Center, Naval Base, San Diego; Dr. Barbara Hartmann, University of Arizona Health Sciences Center, Tucson, Principal Investigator for the Navy Alcohol and Drug Safety Action Program (NADSAP), Ms. Camille Ross, NADSAP Evaluation Coordinator, Ms. Viktoria Johnston, NADSAP Site Coordinator. Data recording space was generously provided by the Family Advocacy Center, Naval Base, San Diego.

The objective of this project was to determine the feasibility of using electrophysiological techniques to evaluate drug abuse training materials.

J. C. McLACHLAN  
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## Summary

### Objective

Evaluating attention to, and interest in, training materials depends primarily on voluntary verbal and written feedback from individuals, usually in the form of questionnaires or tests. The objective of this report is to describe research, which would determine the feasibility of using electrophysiological methods to assess the effectiveness of drug abuse prevention training. Literature in the areas of program evaluation, drug abuse prevention models, research and evaluation, cognitive processing, susceptibility to substance abuse, and advertising and consumer research will be reviewed.

### Approach

Drug abuse prevention video tapes were evaluated using irrelevant auditory probes to generate event-related brain potentials (ERPs) from the scalp frontal regions of 26 individuals ( $27 \pm 7$  years). The subjects were divided equally into two interest groups (HIGH vs. LOW) based on questionnaire factor analysis scores. Irrelevant tone probes were 1500 and 750 Hz, 50 ms duration, and 75 dB(A). ERPs from the frontal electrode (FZ) site were digitally referenced to linked mastoids, sampled at 128 Hz, and digital bandpass filtered at 1-12 Hz. Comparisons were made between prevideo baseline (30 sec) and video material (30 sec) for the HIGH and LOW interest groups.

### Results

With all subjects combined, statistically reliable differences were found between prevideo and video segments for the ERP negative component at about 90 ms ( $t = -2.78, p < .01, df = 24$ ). For the HIGH interest group, prevideo versus video material differences for this same component were statistically significant ( $t = -2.23, p < .025, df = 24$ ). Differences were also found for the LOW interest group, but were marginally significant ( $t = -1.78, p < .05, df = 24$ ). When prevideo baselines for the HIGH and LOW groups were compared, no differences were found for any components between 50 and 200 ms. Large statistically significant differences were found between the HIGH and LOW interest groups for the ERP component at about 150 ms recorded during the video conditions ( $t = 2.59, p < .01, df = 24$ ).

### Conclusion

The results of this research support the notion that ERP data, using irrelevant probe stimuli, may be useful in assessing education, training, and other video and auditory materials. Earlier literature showed that using EEG and "late" ERP components could be used to evaluate advertising approaches and commercial products. The current research extends those results to the assessment of video materials using "early" ERP components. The current research suggests that using auditory "irrelevant" probe stimuli, and the resulting ERP records, may provide an unobtrusive and objective measure of information, which may not be available through traditional behavioral measures. It is presumed that with improved assessment of "interest" in education and training materials, improved efficiency and effectiveness of drug abuse and other education and training materials would be achieved.

## **Recommendation**

It is expected that with further development, "early" ERP components may improve assessment of the effectiveness of education and training materials. Recommendation is made that the use of electrophysiological assessment be made during the development of education and training materials used by the Department of Navy.

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# Introduction

## Objective

The objective of this report is to describe research, which would determine the feasibility of using electrophysiological methods to assess the effectiveness of drug abuse prevention training. Literature in the areas of program evaluation, drug abuse prevention models, research and evaluation, cognitive processing, susceptibility to substance abuse, and advertising and consumer research will be reviewed.

## Background

The current literature review is organized into the following nine categories: drug usage, Navy drug and alcohol abuse programs, factors contributing to initial drug abuse, program evaluations and research, drug abuse prevention models, research and evaluation, information processing and behavioral change, electrophysiological recording, susceptibility to substance abuse, and advertising and consumer research.

### Drug Usage

Estimates have been made that almost two-thirds of prospective employees in the general population have used illegal drugs (Tyson & Vaughn, 1987). Between 12 percent and 20 percent of adults (18 years and above) abuse one or more drugs, and as many as 5 percent of all employees have a chronic drug abuse problem (Radford, Rankin, Barnes, McGuire & Hope, 1983). It has been estimated that between one and three million cocaine abusers are in need of treatment, and that nearly 50 percent of U.S. citizens between 25-30 years of age have tried cocaine (Gawin, 1991). Even though the trends in drug use has shown a decline from 1979 (34%) to 30 percent in 1985, to about 25 percent in 1988 (National Institute on Drug Abuse, 1991), the annual cost of drug abuse to society has been estimated to be \$100 billion (Department of Health and Human Services Report to Congress, 1987). There have been large amounts of funding dedicated to fighting illegal drugs in the U.S. However, a recent Senate Judiciary Committee Report showed that more individuals have become addicted to cocaine or heroin, fewer able to get treatment and the homicide rate due to drug abuse increased from 1989 levels (*San Diego Union-Tribune*, 1992). Ostrow (1992) stated that usage of cocaine increased from 1.6 million in 1990 to 1.9 million in 1992, the number of emergency room episodes showed that there was an increase in cocaine and marijuana use by those aged 35 and older, but the overall drug use by adolescents dropped from 6.4 million in 1990 to 6.2 million in 1991. Johnston, Bachman, and O'Malley (1983) discussed trends in drug use, attitudes, and beliefs.

### Navy Programs

The Department of Navy (DON) has instituted a Demand Side Counternarcotics Research, Development, Test, and Evaluation program managed by PERS-63. Funding is from the DOD Office of Coordinator for Drug Enforcement Policy and Support, which was established by DOD Directive 5149.9. This program will use many existing technology-based developments, and will initiate technology development where needed, to reduce the demand of DOD personnel drug

abuse. Among the specific aspects to be addressed are drug education and training, screening DOD personnel for drug dependency, and rehabilitation.

The Navy has been involved with prevention education dealing with potential adverse lifestyle behaviors since the early 1980s (Adm. Hazard letter 1991 in Hartmann, 1992). Such training was available through the Navy Alcohol and Drug Safety Action Program (NADSAP). A wide range of behavior changes are presented to Navy department personnel in the Program for Personal Responsibility curriculum (Hartmann, 1992). These included stress management, adaptability, problem solving/decision making, communication, nutrition, sexual behavior, and drug and alcohol information. Intervention and prevention populations have been compared after leaving the NADSAP program, and it was found that intervention students showed greater improvement than prevention students. It was estimated that the Navy would save about \$3.3 million yearly from NADSAP instruction, primarily through reduced alcohol problems and non-judicial punishment incidences (Hartmann, 1992). Overall effectiveness of Navy drug detection and prevention programs, such as the Navy Alcohol and Drug Abuse Program has been shown to be considerable, and unit command personnel have listed detection (42%) and prevention (41%) programs as the top priority for future funding. The remaining 17 percent specified that deterrence programs should receive top priority (Bishop, Blalock, Kerner-Hoeg & Peters, 1992).

The Navy Alcohol and Drug Safety Action Program (NADSAP) was modified to include a discussion of a broad range of risky behaviors and techniques to improve interpersonal coping skills of the students. This course was then called "Personal Responsibility and Values Education and Training" (PREVENT). A recent Navy News Service (NNS1612, 16 April 1997) article announce the availability of a new PREVENT course, PREVENT 2000:

This revised course, offered at 18 sites Navy-wide and designed for 18-26 year old Sailors, addresses issues such as alcohol abuse and drug use prevention, interpersonal relations, health and readiness and financial responsibility. Navy core values and personal responsibility are the heart of this course, which helps Sailors develop improved communication and interpersonal skill, as well as planning and decision making capability.

The course is a key component of the Navy's "Right Spirit" Alcohol Abuse Prevention Campaign. The goals of "Right Spirit," launched in 1996 by Secretary of the Navy John H. Dalton, are to enhance fleet readiness by reducing alcohol abuse and related incidents, to maintain a safe and productive working

environment, and to ensure quality of life for Navy members, shipmates, their families and the communities where they live.

Other military drug abuse prevention programs have been available for many years (U.S. Army Handbook, 1975), even though earlier drug education programs in the Army were found to be ineffective (Cook & Morton, 1975). These authors found that background and situational factors were much more influential in making behavioral changes in drug use than drug education factors.

### **Factors Contributing to Initial Drug Abuse**

Causal factors of drug abuse and prevention programs have been associated formally within NIDA since about 1982 (Jones & Battjes, 1985). They reviewed the basic structures of prevention programs. Earliest drug abuse prevention programs were almost always focused on presenting only information. These programs were followed by ones that emphasized more of the social and psychological factors. Newcomb, Maddahian, and Bentler (1986) have noted that risk of using and abusing drugs is related to so many factors, that general categories, similar to those used in epidemiology, are best used. These categories include environmental, behavioral, psychological, and social attributes. Early research in the area of initial abuse of drugs has suggested the importance of the immediate family and peer relationships. Lewandowski and Westman (1991) showed that strong family relationships did not necessarily deter drug use, and they suggested that improving adolescent's interpersonal relationships may be more important than providing new alternatives. An extensive annotated bibliography has addressed the relationships between personality variables and drug users (Einstein, 1983). A National Institute on Drug Abuse (NIDA) book (ADM-84-1152) has been dedicated to adolescent peer pressure and brings together theory and program planning for improved drug abuse prevention. In this same NIDA book, Varenhorst (1981) discussed theoretical issues, including difficulties of adolescent development. In addition, Norem-Hebeisen and Hedin (1981) covered the influences on adolescent problem behavior, while Resnik and Gibbs (1981) discussed various peer program approaches. Social and organizational factors were found to make major contributions to illegal drug use in the U. S. Army (Cook, Walizer, & Mace, 1976). Negative impressions of one's self, or other individuals also has been shown to contribute to the initial use of drugs (Long & Scherl, 1984). Gorsuch and Butler (1976) showed that other factors such as personality, socialization to nontraditional norms, positive drug experience and interactions of peers who use drugs were major influences in the initial use of drugs. Not all persons who tried drugs became users or abusers. They suggested that because conditions may differ between those individuals who tried drugs and did not continue drug use, and those who became habitual users, different models should be used for those who only tried versus those who became heavy users. Hillman and Sawilowsky (1991) suggested that differences between users and abusers followed several multidimensional lines. These lines showed that abusers were older, had fewer activities, exhibited more risk taking behavior, and had greater difficulty in refusing drugs if drugs were offered, than users. However, they did find unexpectedly that abusers had a higher grade point average than did users.

Another approach to the initial use of drugs included the use of "gateway" drugs. Progression from mild compounds like coffee, tea, and cigarettes, to beer and wine, to hard liquor, to illicit drugs like cocaine has been documented (Kandel, Kessler, & Margulies, 1978).

The complex interaction of psychological, environmental, and neurophysiological factors has demonstrated that cocaine addiction has gone from a little or no problem to a major one in the last 10 years (Gawin, 1991). Cocaine effects produced very unique abuse manifestations and did not appear to have many withdrawal adverse effects found in other drugs of abuse (Gawin, 1991). As a result, cocaine use and abuse patterns may have major implications for improving the effectiveness of prevention and/or treatment programs.

### **Program Evaluations and Research**

In view of the difficulties associated with the treatment of individuals who have already become substance abusers, the prospect of developing effective prevention strategies holds a great deal of appeal. For a variety of reasons, however, the development of effective substance abuse programs has remained an elusive goal until very recently. While prevention efforts have only begun, significant progress in related areas provides preliminary support for the efficacy of several new substance abuse prevention models [Department of Health and Human Services (DHHS) Report to Congress, 1987].

More than 40 theories of substance abuse have been developed (Lettieri, Sayers, & Pearson, 1980). Nearly all of these theories have dealt with social, personal, cognitive, and environmental causal factors of substance abuse. Very few theories appear to have relevance for prevention programs (DHHS Report, 1987). The DHHS Report further states that

Unfortunately, the inescapable conclusion to be drawn from the substance abuse prevention literature is that few of these programs have demonstrated any degree of success in terms of actual prevention of substance abuse. Traditional educational approaches to substance abuse prevention appear to be inadequate because they are too narrow in their focus. The "affective" or "humanistic" education approaches, on the other hand, appear to have placed too little emphasis on the acquisition of skills that are likely to increase general personal competence



and enable students to cope with the various interpersonal and intrapersonal pressures to begin using tobacco, alcohol, and drugs.

Support for these conclusions were found in papers by Berberian, Lovejoy and Paparella, 1976; Braucht, Follingstad, Barkarsh and Barry, 1973; Dorn and Thompson, 1976; Goodstadt, 1974; and Swisher and Hoffman, 1975. Restricting the content of drug prevention programs to only factual information may have an opposite of intended affects, that of increasing drug use (Swisher, Crawford, Goldstein, & Yura, 1971). The latter report noted that the most successful prevention programs generally were based on strong theoretical foundations, strong research design, and subsequent evaluation. Teaching social resistance skills along with other social and personal skills has shown promise (Botvin, Baker, Filazzola, & Botvin, 1990). Other government reports site that little is known about prevention program effectiveness (GAO Reports HRD-91-27, 1990), some drug prevention programs show promise (GAO Report PEMD-92-2), and those programs in rural areas are heavily dependent on federal funding (GAO Report HRD-92-34).

Even though there has been support for theory-based program evaluation (Chen, 1989; Chen & Rossi, 1980, 1983, 1987, 1989; Cordray & Lipsey, 1986; Bickman, 1987), barriers such as cost, motivation, and knowledge have restricted the implementation of a strong evaluation program (Bickman, 1989). Key to any prevention program, the goal of which is to change high risk behavior, is the careful selection and evaluation of content material (Leviton & Valdiserri, 1990). Improving prevention programs depends on adhering to specific methodological issues. Bry and George (1979) suggested using health-oriented, not pathology-oriented, outcome measures, several settings and outcome measures, and recording process variables. While there are objective data on overall prevention program evaluation, there has been little or no data relating the effectiveness of selected material, and individual responsiveness of students undergoing the prevention education program. A detailed set of guidelines for prevention evaluation has been developed by French and Kaufman, (1981). They address the evaluation of programs at the macro program level, not at the level of the individual.

Mass media influence in preventing substance abuse has been discussed (Flay & Sobel, 1983), and they suggested that on television, the primary medium for adolescents, pro-drug commercials, and incidences outnumber anti-drug by several fold.

### **Drug Abuse Prevention Models, Research, and Evaluation**

Reports reviewing several categories of drug abuse prevention research has been done by Glynn (1983) and Glynn, Leukfeld, and Ludford (1983). They covered 15 literature reviews, 22 theoretical and issues-oriented papers, and 28 data-based papers. Newcomb and Bentler (1989) reviewed the epidemiology (patterns of use), etiology (causes), prevention, treatment, and consequences of drug abuse. They defined a distinction between use and abuse of drugs and developed a concept which took into account the drug, individual, his/her response, and consequences. Prevention programs emphasizing knowledge and affective approaches have generally not worked when environmental and social factors were not taken into account. Two major reviews have suggested that most prevention programs have not been very effective (Bangert-Drowns, 1988; Tobler, 1986). Schaps, DiBartolo, Moskowitz, Palley, and Churgin

(1981) examined the outcome effectiveness for 127 drug abuse prevention programs. On balance, they found that the programs had only slight effects on changing attitudes and behaviors related to drug use.

Relationships between drug abuse and psychological characteristics was investigated longitudinally by Shedler and Block (1990). They found that those individuals who used drugs frequently could be described as being socially maladjusted and had poor impulse control. Drug abuse behaviors have been considered symptoms and not necessarily the cause of personal and social maladjustment. When they compared drug users and abstainers, differences were noted in the quality of parenting the individuals received when young. Shedler and Block suggested that current drug prevention efforts may be misguided because they focus on symptoms, and not the psychological factors underlying drug abuse.

Jones (1987) described the Health Action Model (HAM) and provided an overview of various psycho-social and environmental factors. This model described the interaction of knowledge, beliefs, values, attitudes, drives, and normative pressures, and sought to show how these factors related to individual intentions to act. It also indicated how environmental circumstances, information, and personal skills may facilitate the appropriate behavioral action. The primary purpose of the HAM was to incorporate environmental, inter-personal, and intra-personal factors, which may influence individual decision making and focused on education. HAM also considered the importance of factors dealing with which may facilitate or inhibit behavioral action.

Gonzalez (1989) emphasized the importance of the Health Belief Model (HBM), which assumed that motivation was a necessary condition for action and that motives selectively determined one's perception of the environment. Social Learning Theory (SLT), Bandura, 1977, 1986 countered the lack of influence of environmental factors in the HBM. The SLT conceptualized alcohol and other drug use as a socially learned, purposive, and functional behavior, which was the result of the interaction between socio-environmental factors and personal perceptions. Prevention approaches based on SLT have placed emphasis on the development of specific social and personal skills to resist pro-drug environmental and peer pressures among individuals. The SLT has combined efforts to correct perceptions of social norms with individualized instruction on peer refusal and social skills.

Psycho-social programs in drug prevention fall into two categories: programs that focus primarily on social influences believed to promote substance use, and training approaches designed to improve personal and social competence. The social influence approaches have sought to increase students' resistance to group social pressures to smoke and use drugs by helping them develop effective counter arguments. These approaches have included characteristics such as assertiveness skills, effective interpersonal communication skills, social skills, and decision-making skills. The Gonzalez prevention program design provided a framework for structuring preventive campus alcohol and other drug education programs in terms of message content, implementation process, and levels of intervention. He suggested that a consistent message regarding problem severity, personal susceptibility, and viable alternatives should be an integral part of all informational efforts in the program.

Barber, Bradshaw, and Walsh (1989) described research of regular drinkers whose behavior was known to be unaffected by a previous antidrug advertising campaign and were used to assess the impact of a television commercial. The objective of the commercial campaign was to raise community awareness of drug abuse generally and to provide basic information about the nature of, and extent of, the problem. These advertisements produced no behavioral effects in the short term, but it was found that pretesting sections of the viewing public intensified the effect of the campaign on attitudes toward alcohol and tobacco, resulting in more conservative attitudes to both substances. It was noted that the use of advertising slogans were inadequate in producing behavior change. Behavioral self-control training was the approach used in this research and included goal-setting, self-monitoring, training in rate control, self-reinforcement procedures, functional analysis of drinking behavior, and instruction in alternatives to alcohol use. The television commercial consisted of the following controlled-drinking components: (1) normative information (hazardous consumption level); (2) goal-setting and shaping (instruction to set gradually reduce intake levels); (3) instruction in rate control, including taking smaller and slower sips, putting the glass down between sips, drinking non-alcoholic drinks, etc.); and (4) motivational prompting (encouraging the viewer to follow these steps and to keep trying). Barber, et. al. (1989) showed that there was a 46 percent reduction in last weekend consumption, a 52 percent reduction in typical weekend consumption, 84 percent reduction in yesterday consumption, and a 47 percent reduction in typical day consumption.

Prevention programs based on social aspects and preventing the use of "gateway" drug such as cigarettes, alcohol, and marijuana has been found to be only marginally effective. Ellickson and Bell (1990) found that gains in alcohol reduction by seventh grade students were not sustained when the students reached the eighth grade. In addition, there was an increase in cigarette smoking by previously confirmed cigarette smokers.

Pellow and Jengeleski (1991) found encouraging results when prevention programs focused on resistance education training. Drug Abuse Resistance Education (DARE) and other programs that emphasized intervention strategies were found to be effective. They described three drug educational program categories as those that focused on supplying factual information about drugs (prevention), those that were concerned with attitudes, feelings, and values (prevention), and those that dealt directly with behavior (intervention). Project DARE has received national recognition. DARE has been a substance abuse prevention education program taught by uniformed officers designed to assist in developing fifth and sixth grade students with improved skills for decision making, problem solving, and coping with and resisting peer pressure. It was noted that successful drug prevention programs addressed peer pressures to use drugs and the adolescent belief that using drugs may be socially advantageous.

Walker (1990) evaluated the DARE program in the Greater Victoria School District, British Columbia, Canada. She stated that evaluating prevention programs such as the DARE program may be difficult because program success translates to no or little drug use in the future. Several questionnaires were given to 857 students prior to and after DARE training. These covered drug knowledge, risks and consequences, as well as the degree of satisfaction of principals, teachers, parents and officers. Even though the individuals involved with the DARE program showed high satisfaction, the results were inconclusive in showing that the DARE program was a viable drug abuse prevention program.

Effective drug education programs over a 15 year period were reviewed by De Haes (1987). He described three approaches to drug education effectiveness: (1) a warning approach, (2) an informative approach, and (3) a person-oriented approach in which involved 1,035 students from ages 14 to 16. Attitude changes on the different attitude factors were closely related to the messages contained in each of the three programs. From a behavioral point of view, none of the students experimenting with drugs changed their behavior, regardless of which approach was used. It was concluded that substance oriented drug programs, whether purely informative or warning, may have a stimulating effect on drug experimentation. A second conclusion indicated that talking about problems that young people have, as in the person-oriented approach, may be effective in reducing drug experimentation.

Leukefeld and Bukoski (1991) and Bukoski (1991) discussed several theoretical and methodological issues relating to drug abuse prevention research and the effectiveness of prevention intervention programs. Design and methodology differences across research investigation, inconsistent findings, and outcome measures such as no versus some drug use contributed to problems in drug abuse prevention research. Flay and Petraitis (1991) emphasized the need for theoretical foundations in drug use prevention research, and provided an extensive review of theories and issues related to drug use type of prevention research.

Other research has dealt with learning and memory aspects of drug abuse (Levy, 1990; Kornetsky, Williams, & Bird, 1990).

### **Information Processing and Behavioral Change**

Several stages must be passed through in order to make behavioral changes. Flay & Sobel (1983) note that there are common ideas between mass media health promotion programs and drug abuse prevention programs, and are based on concepts described by Cartwright (1949). These include providing an appropriate cognitive (information), motivational (fear, arousal), and action (change behavioral patterns) structures.

Several studies have shown relationships between repetitiveness and novelty of information in education material, and resulting effectiveness of the education material. McCullough and Ostrom, (1974) found that attitudes were changed through repetitive presentations of similar material. Cacioppo and Petty (1979, 1980) studied attitude and cognitive effects when persuasive messages were repeated. They found that subjects initially showed increased agreement, then decreased agreement, with message frequency. They suggested that content and repetition of messages affected cognitive processing, which in turn affected their attitudes. Novelty of stimuli may affect behavior. Berlyne (1970) showed that stimuli, which were related to "pleasingness" and "interestingness," were related to novelty.

Even though television commercials may be effective when first run, subsequent exposures may lead to a decrease in advertising effectiveness, often called *wearout* (Grass & Wallace, 1969; Appel, 1971). Calder and Sternthal (1980) noted that wearout may be due to first, the individual not paying adequate attention after repeated presentations (Craig, Sternthal, & Leavitt, 1976), and second, to information processing not being related to attentional factors (Wright, 1973). The information processing concept suggested that an individual may be processing two types of thoughts during exposure to advertising, one dealing directly with the message content

and those dealing with all other thoughts. Calder and Sternthal (1980) found support for the finding that when an advertising message is repeated, individuals tend to shift thinking from more positive ideas from the message content to less positive other ideas. These research findings suggest that information processing, in addition to attentional factors, may be an important factor in message retention.

A large area of cognitive processing research, theory, and modeling has involved cognitive resources, attention, and automatic versus controlled task processing (Posner & Petersen, 1990; Posner & Snyder, 1975; Schneider, 1985; Schneider & Shiffrin, 1977; Schneider, Dumais & Shiffrin, 1984; Shiffrin & Dumais, 1981; Shiffrin & Schneider, 1977). Automatic processing has been defined as not dependent on attention, very fast, generally immutable, and generally implied parallel processing; whereas, controlled processing has been defined as attention bound, slow, serial, and could be changed under the individual's control. Tiffany (1990) has adapted the automaticity-controlled cognitive processing model to drug urges and drug usage. He has developed an elaborate model, which suggests that drug use in addicts may be controlled by more automatic processes, while drug urges may be governed by more controlled (nonautomated) processes. Even though much of Tiffany's work dealt with urges and drug use behavior, there may be implications in his work for prevention education programs.

New concept in modeling of stage-sequential growth of individuals has recently been applied to substance use prevention applications (Graham, Collins, Wugalter, Chung, & Hansen, 1991).

### **Electrophysiological Recording**

Individual performance levels, including training, are determined by alertness, attention, quality and quantity of sensory and cognitive processing. These determining factors may be objectively indexed through neuroelectric and neuromagnetic physiological techniques. Neuroelectric recordings (electroencephalogram, EEG) are obtained through contact electrodes attached to the scalp, and reflect minute voltages resulting from brain processing. Neuromagnetic recordings (magnetoencephalography) use cryogenic and superconductivity technology, do not require scalp contact, and measure very minute brain magnetic fields.

For more than 50 years, the research literature has suggested that there are large individual differences in the electrical, and more recently magnetic, activity in the brain. There is also evidence that some of the characteristics of brain activity may be stable when measured from day-to-day (Lewis, 1984). Brain responses to sensory stimulation (e.g. visual, auditory, somatosensory, olfactory, gustatory) as well as higher-order cognitive processing (e.g., decision-making), now can be examined in great detail using a variety of recording procedures. An on-going record of brain electrical activity records is called an electroencephalogram (EEG), and a comparable record of magnetic activity is called a magnetoencephalogram (MEG). EEG and MEG records usually have a great deal of uncontrolled variation, and special techniques are necessary to stabilize activity patterns. Brain activity can be stabilized by strict control of the conditions under which brain responses are generated. When human sensory systems are stimulated by an event, such as a flash of light or a tone, there is a predictable sequence of processing that occurs in the brain. This processing generates an event-related potential (ERP) that can be recorded from the scalp beginning shortly after the onset of stimulation, and lasting

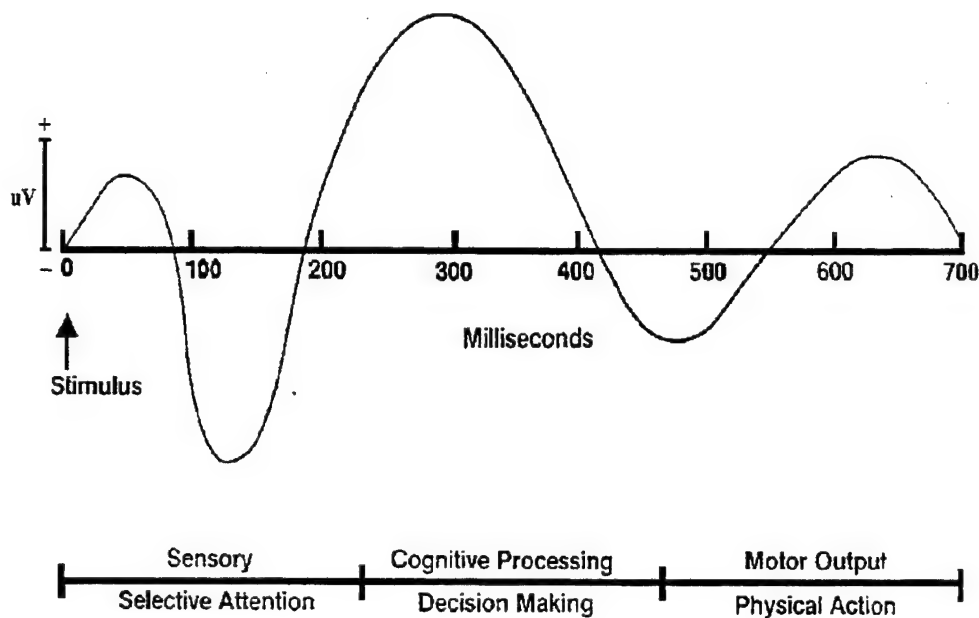


for 1-3 seconds after the stimulation. These ERPs can be repeatedly generated from individuals given the same stimulus. Due to the low amplitude of the signal, it is often necessary to repeatedly sample the response to the stimulus, and to average the response patterns. ERP measures are in the microvolt range (uV, millionths of a volt). Comparable records of averaged magnetic activity are called evoked fields or event-related fields (ERFs). Neuromagnetic measures have only recently been possible. Due to the low amplitude of the signal, special low-temperature systems are required to measure the magnetic signals emitted by brain tissue. The unit of measurement is femtoTesla ( $10^{-15}$  Tesla). Neuroelectric and neuromagnetic recordings are subsets of more general measures, called bioelectric and biomagnetic measures. Bioelectric and biomagnetic measures refer to recordings from all types of tissue including neural, muscle, heart, and lungs.

This Center has had an extensive history of demonstrating relationships between EEG, MEG, ERP, and ERFs and job performance (Lewis, 1979; Lewis & Froning, 1981; Lewis, 1983; 1984; Lewis & Ryan-Jones, 1996; Lewis & Sorenson, 1989; Lewis, Blackburn, Naitoh, & Metcalfe, 1985; Lewis, Trejo, Nunez, Weinberg, & Naitoh, 1988; Lewis, Trejo, Naitoh, Blankenship, & Inlow, 1989).

Early research relating EEG to cognitive processing was limited to the hemispheric lateralization model. This model suggested that verbal, sequential functions were performed in the left hemisphere, while spatial, simultaneous, integrative functions were performed in the right hemisphere (Galin & Ellis, 1975; Kinsbourne, 1972; Knights & Bakker, 1976; Mintzberg, 1976). Lateral asymmetry has not been supported by applied psychophysiological data (Lewis & Sorenson, 1989). Gevins, Zeitlin, Doyle, Yingling, Schaffer, Callaway and Yeager (1979) found that when adequate controls for limb movement and other noncognitive factors were made, no lateral asymmetry was found. The severe limitations of using EEG in evaluating advertising effectiveness, and as well general education and training effectiveness is overcome in the use of the event-related brain potential. The largest problem of using EEG recordings, other than for general alertness assessment, is the lack of stimulus-response control. The ERP overcomes this limitation with the use of stimuli, or probes (relevant and irrelevant). A large literature has developed in relating the ERP to many aspects of attention and cognitive processing (Coles, Gratton, & Fabiani, 1990; Hillyard & Picton, 1987; Lyytinen, Blomberg, & Naatanen, 1992; Naatanen, 1988, 1990; Naatanen & Picton, 1987; Naatanen, Gaillard, & Mantysalo, 1978; Naatanen, Paavilainen, Tiitinen, Jiang, & Alho, 1993; Teder, Alho, Reinikainen, & Naatanen, 1993).

General alertness may be measured by on-going EEG activity. In order to effectively measure selective attention, and sensory and cognitive processing, event-related brain potentials (ERP) must be obtained. The ERP records are obtained by presenting stimuli (i.e., visual and/or auditory), and generating a signal average. The resulting ERP reflects microvolt deflections from baseline. These deflections appear at fairly specific time points, and are referred to as ERP components. Attention, sensory processing, cognitive (decision making) processing, and motor output processes are associated with these components, and may be seen in Figure 1. Probe targets, or stimuli, are used to generate the ERP and may be either relevant or irrelevant in nature to the subject. For this project, auditory irrelevant probe stimuli were used to generate the ERP records.



**Figure 1. Example ERP waveform.**

### **Susceptibility to Substance Abuse**

Many research findings have shown relationships between personality and environmental influences in substance abuse. In recent years however, increasing evidence has suggested that there may be a genetic component. Coninger (1987) has described three different dimension of personality (novelty seeking, harm avoidance, reward dependence), and suggested the importance of heritability of these variable to the understanding of susceptibility of alcohol abuse. He discusses neuroadaptive systems that are involved in the development of personality characteristics and related to the susceptibility to alcohol abuse. Other papers have described relationships between genetic components and alcoholism (Cadoret & Gath, 1978; Cloninger, Bohman, & Sigvardsson, 1981; Goodwin, 1979; Goodwin, Schulsinger, Hermansen, Guze, & Winokur, 1973; Goodwin, Schulsinger, Moller, Hermansen, Winokur, & Guze, 1974).

More than a decade ago, relationships were noted between ERPs of high and low risk subjects for alcoholism (Elmasion, Neville, Woods, Schukit, & Bloom, 1982). Begleiter, Porjesz, Bihari and Kissin (1984) described relationships between electrophysiological recordings and potential susceptibility to alcohol abuse. As noted earlier, electrophysiological (neuroelectric) recordings include on-going electroencephalographic data (EEG), and within EEG records, the stimulus-generated event-related brain potentials (ERPs). They showed that the P300 ERP component, the positive voltage component at about 300 msec, from a group of 25 young males (7-13 years), who were sons of alcoholic fathers differed from those of age and sex matched controls. Begleiter, et. al., suggest that the decreased amplitude of the P300 component in the high risk group may suggest a reduced capability to allocate resources for encoding and memory tasks. Begleiter and Porjesz (1990) have reviewed the literature related to electrophysiology and risk for alcoholism. Sponheim and Ficken (1991) also have noted decreased P300 amplitude in young male subjects with a positive family history for alcoholism

compared with control subjects. Recently, Berman, Martinez, and Noble (1991) described late positive ERP components (430-490 msec) to be reduced in a group of young males at risk for alcoholism which they attribute to different processing of stimulus features. A later ERP component (N400) related to language processing was found to be reduced in a group of male subjects with a positive family history for alcoholism (Schmidt & Neville, 1985). Other papers have explored parametric relationships for ethanol consumption and ERPs (Campbell, Marios, & Arcand, 1984), ERP component in alcoholics (Johnson, Pfefferbaum, Hart, & Kopell, 1984; Skerchock & Cohen, 1984), ERP components and antisocial behavior (Raine & Venables, 1987).

### **Advertising and Consumer Research**

This project deals with evaluating whether electrophysiological activity may improve the effectiveness of education and training in drug abuse prevention programs. Specifically, the area of evaluating interest in the training material is of concern. There are many important aspects of drug abuse prevention education which relate to program effectiveness. Some of these include methods and modes of presentation, determining the effectiveness of disseminating knowledge and concepts, and marketing strategy. An area of research which has potential direct relevance to evaluating drug abuse prevention program material is associated with advertising and consumer psychology. *If one is participating in an education program or marketing a particular product, the goal is to sell the item, whether the item is a specific education concept or other material product* (our italics for emphasis).

Central to effective advertising is persuading the individual to buy a product or change behavioral attitudes as in the case of drug abuse prevention. Cognitive psychology has made major contributions to understanding the effects of advertising and persuasion. A number of papers have been published in this area (Calder, Insko, & Yandell, 1974; Greenwald, 1968; Greenwald & Leavitt, 1985; Krugman, 1965; Sawyer, 1980; Wilson & Muddersoglu, 1980; Woods, 1990; Memory is an important part of effective advertising because consumers usually do not make purchases during or immediately after being exposed to advertising material. Keller (1987) has studied advertising retrieval cues in addition to brand name recognition. He stated that competitive advertisements interference and consumers processing goals are also major contributing factors in consumers' advertising memory. Essential to effective advertising, or education programs is that of communication of ideas and processes. Olson, Toy, and Dover (1978) mention that the lack of understanding of the communication process may be due to the lack of related research, which is process oriented. Their research investigated mediating effects and cognitive structure in advertising. Theoretical developments have provided improved cognitive models of important advertising components such as persuasion. Other research has dealt with cognitive response, recall and message acceptance in television advertisements (Belch & Lutz, 1982). Mitchell (1986) suggested that four stages must be passed through for effective persuasion. These included attention, message comprehension, yielding, and message retention. Effective message acquisition, encoding and retrieval is heavily dependent on attention and resources devoted to the cognitive task at hand (Kahnemann, 1973; Navon & Gopher, 1979). Cognitive processing strategy is also important for effective learning and understanding. Mitchell (1983) suggested that second-level factors affect the amount of attention that may be dedicated to processing information in an advertisement. He also noted message relevance (Petty



& Cacioppo, 1981), product category and brand (Edell & Mitchell, 1978), and modality (Wright, 1973).

Advertising and consumer research has been done using both traditional behavioral methods and electrophysiological procedures for several years. The apparent first research relating ongoing electrical brain activity (electroencephalography, EEG) to the effects of advertising on individuals was by Krugman (1971). He examined differences due to television and magazine advertisements, and found that alpha level in the EEG (8-12 Hz associated with arousal level) was the same for both television and print media. He also found that there was more low frequency activity (2-7 Hz correlated with very low arousal levels) and less beta (12-20 Hz correlated with high arousal levels) associated with television than magazine media. Olson & Ray (1983) have reviewed the early literature relating EEG measures to the effects of advertising. They issued caution in ascribing psychological meaning, and believing assumptions about EEG alpha frequencies and hemispheric lateralization effects in advertising research without much more research. They also criticized the lack of criteria, in that three of the four studies used only the criterion of unaided brand name recall. Stewart and Furse (1982) have also reviewed the use of EEG recordings in evaluating television commercials. In a more recent report, Olson and Ray (1989) explored the use of EEG in the evaluation of advertisements presented with two different execution styles. The first style had an attribute-oriented (AO) execution, while the second had an emotion-oriented (EO) execution. AO ads emphasize product benefits or specific attributes, while the EO ads try to emphasize a particular emotion with the product. Olson and Ray did find some relationships of their EEG recordings to these two styles. However, even though there was more EEG activity produced from female subjects than male subjects, there were no differences between sexes in response to the AO and EO presentations. These authors found little hemisphere laterality differences due to the different AO and EO presentations. Olson and Ray concluded that even though there may be evidence linking EEG recordings to cognitive and emotional processing, there is little conclusive evidence that the EEG approach is a valuable assessment tool for advertisement assessment.

Alwitt (1985) found some indication that alpha (8-12 Hz) EEG frequency in the parietal region did relate to reaction of brand and message content, while beta<sub>2</sub> frequencies (16-28 Hz) in the frontal region related to her four classes of execution variables such as physical events (cuts and zooms), brand/message events (brand name mention), reactions (cognitive/emotional), and communication media (visual/auditory).

Interesting relationships between EEG/ERP measures and commercial advertisements have been found relating to ad content and media presentation (Weinstein & Weinstein, 1978; Appel, Weinstein & Weinstein, 1979; Weinstein, Appel & Weinstein, 1980; Reeves, Thorson, Rothschild & McDonald, 1985), evaluating communications effects of advertising (Weinstein, Weinstein & Drozdenko, 1984); validation and replication of EEG/ERP and advertising relationships (Weinstein, Drozdenko & Weinstein, 1984); the effects of subliminal cues associated with candy and book ads on purchase intent and brain activity (Weinstein, Drozdenko, & Weinstein, 1986); and consumer responses to advertising (Price, Rust & Kumar, 1986). Rothschild and Hyun (1990) found that the probability of correct recognition of television commercial components were enhanced during alpha blocking and when hemispheric laterality measures shifted to the right, then the left hemisphere.

## Research Objective

Attention and interest will be assessed by using the irrelevant probe ERP technique (Papanicolaou & Johnstone, 1984). Resource allocation theory (Wickens, 1980, 1984) as well as attention allocation are appropriate concepts for assessing training material attention and interest. For example, even when a subject is instructed to not attend to a stimulus (auditory irrelevant probe), an ERP will be generated from the irrelevant probe. When a subject performs a task, such as viewing video material, in addition to being presented the irrelevant probe stimuli, resources will be diverted from the irrelevant probe to the video task, and a corresponding decrease in ERP component amplitudes will occur. These measured changes index the resources related to interest or attentional demand. The more interest in the video material, the greater the resources diverted to the video material. Consequently, it is expected that the ERP data will distinguish between video materials that prove of interest to the subjects and video materials that may be of little interest to the subjects.

## Method

### Video Material

An extensive review of PREVENT course training materials was made for possible inclusion as experimental presentation material. Video tape material, presented as part of the PREVENT course, was obtained from both DAPMA and the University of Arizona for evaluation and possible inclusion in the experimental protocol. Two video segments were selected for presentation. They included "Marijuana and Driving" and "Experience of Addiction." Each of these segments was 2-4 minutes in length. A video segment titled, "Concentration" was selected as a control condition. This latter segment had a similar video format as the two experimental segments, but did not deal with drug abuse training material. The subject matter dealt with Olympic runner athletes preparing themselves for competition. In addition, a number of 30 second television commercials dealing directly with drug abuse prevention were evaluated. Three commercials were selected from material produced by Partners for a Drug Free America, a joint commercial television and advertising industry effort. The three selected commercials included "Nose," "Nothing Happens," and "Housewife." The segments of video material were presented in two randomized sequences, one sequence for subjects with odd serial numbers and the other sequence for those subjects with even serial numbers. For this report, only the electrophysiological data recorded from the 30 second commercial, titled "Nose" will be presented.

### Subjects

Data presented in this report were from a total of 26 subjects, aged  $26.6 \pm 7.4$  years. Of these subjects, 20 individuals were students taking the PREVENT course given at Naval Station, San Diego. Six individuals were DAPMA management and staff members. Each subject was assigned a serial number, required to read the Privacy Act Statement (Appendix A), sign the Consent Form (Appendix B), and fill in the Subject Data sheet (Appendix C) prior to testing. After the video segments were shown to each subject, questionnaires were given to obtain each subject's impressions about the video material (Appendix D). A seven point scale was used to evaluate items such as interest, effectiveness, information content, quality, main characters,

realism, and mood. Factor analyses (FA) were performed on the video tape questionnaire data to determine group membership (HIGH versus LOW). Results of the FA showed that for questionnaire data from the "Nose" video segment, three factors reached the criterion of greater than or equal to an eigenvalue of 1.00. The first factor accounted for 37 percent of the variance and was weighted on the four questions related to realism (0.87), interest (0.75), effectiveness (0.71), and information (0.70). The second factor accounted for an additional 19 percent more variance, and related to whether the subject had seen the commercial before (0.89), and whether the subjects found the main characters likable or not (0.72). The third factor accounted for an additional 13 percent more variance, and related to quality of the subject matter (0.91). Total variance accounted for by all three factors was 69 percent. Factor scores were computed for each subject on each factor. The factor score for each subject on factor one was used as the criterion measure for group membership based on interest and attention in the video material. Criterion factor score for group membership for the HIGH group was greater than, or equal to 0.35 while the criterion factor score for LOW group membership was less than, or equal to 0.12. The HIGH group subjects ( $N = 13$ ) were aged  $22.7 \pm 2.6$  years and the LOW group ( $N = 13$ ) were aged  $23.7 \pm 4.7$  years.

### **Probe Stimuli**

The primary theoretical foundation for this project lies in the resource allocation model of cognitive processing (Wickens, 1980, 1984). When a subject performs a primary task, such as viewing video material, he may also be presented with auditory tones. Allocation of mental resources may be measured by obtaining ERP data generated by the stimulus-locked tones, called irrelevant probes. Sixty percent of the probes were 1500 Hz tones, called "frequent" stimuli, and 40 percent of the probes were one octave lower (750 Hz), and were called "rare" stimuli. The tones were 50 msec in duration with 10 msec rise and decay times. Both tones had the same intensity of about 75 dB(A). Background ambient sound level was about 65 dB(A). The auditory probe stimuli were presented aperiodically with an inter-trial interval of about  $1000 \pm 100$  msec. The subjects were instructed to ignore and not respond to the irrelevant tone probes throughout the data recording session. When subjects divert mental resources from the tones to the primary task, such as viewing video material, ERP component amplitudes decrease. This amplitude decrease reflects the allocation of mental resources, and presumably attention and interest, from the tones to the primary task (video material). If the subject does not have interest in the video material, the shift in mental resources from the baseline (tones only) to the video material (tones plus video) would be minimal, and the ERP component amplitudes would not decrease. Greater ERP amplitude decrease goes with greater shift in mental resources and increased interest.

### **Electrophysiological Data Recording**

Considerable development effort was done for this project in order to improve the application efficiency of electrodes to the subjects. A major improvement in electrode application and recording was obtained by adapting recently developed commercial disposable electrodes used for recording electrocardiogram (EKG) activity from adults and infants. These electrode could be removed and replaced several times with little loss in adhesion and electrical conductivity.

The adult-sized electrodes were 23 mm X 25 mm, and the infant-sized were 12 mm X 20 mm. The infant-sized EKG electrodes were placed above and below the right eye to record vertical electrooculogram (VEOG) activity, as well as at both the right and left outer canthi of the eyes to measure horizontal EOG (HEOG) activity. The larger adult-sized electrodes were placed at both right and left mastoid areas for referencing the three cortical electrodes (frontal, central, parietal). A commercially available helmet with attached electrodes, has been used in the NPRDC Neurosciences Laboratory for several years to record cortical activity, and was used during the current project data recording sessions. Three additional adult-sized EKG electrodes were placed on the right wrist of the subject for isoground, on the left palm thenar area (muscle area at the base of the thumb) for heart rate and skin potential, and on the muscular area of the left palm, across from the thumb to measure skin potential activity. Many tests were made to assure acceptable recording conditions. Impedance, a measure of how well the electrodes are attached, was determined for all of the new electrodes to be about 40K ohms. This impedance was higher than the more traditional electrodes. It was calculated that only 0.4 percent loss in voltage was seen with the new electrodes, which was considered minimal given the great advantage in ease and speed of electrode application. Special clips and lead wires were made to accommodate these new electrodes and worked very efficiently during later testing.

Figure 2 represents the stimulus, recording, and processing system used in this research. The major components of the system are denoted by letters A through I. The individual subject is denoted as A, with the electrodes, B, placed on the scalp. Electrodes, B, were commercially available units made of tin to minimize polarization. Electrophysiological recordings were obtained from the frontal (FZ), central (CZ), and parietal (PZ) regions on the scalp and conform to the location standards of the 10/20 International System (Jasper, 1958). These sites were specifically selected to maximize sensitivity to recording information related to attention, alertness, and interest. Additional recording sites included the left mastoid (M1) and right mastoid (M2) areas. The frontal, central, and parietal electrodes were referenced to the left mastoid region (M1), using separate amplifiers for each data recording channel. An additional amplifier recorded electrical voltage from M1 referenced to the right mastoid area (M2). The electrical activity from M1 and M2 were averaged, in a common technique called digital re-referencing. The channel M2 in Figure 2 was labeled as A2 in Figure 3. All cortical electrodes were digitally re-referenced to linked mastoid regions (behind the ears).

The electrical voltage picked up by the electrodes (microvolts) and was amplified and filtered by the amplifiers, C. One amplifier per electrode and reference pair was used. To ensure adequate recording attachment, the impedance was measured prior to recording. Typical meter readings were 5 KOhms or less. Amplifier gain was 20000 times, and the analog filter bandpass setting was 0.1 - 100 Hz. Sampling rate was 128 Hz.

The amplified signals were fed to a personal computer (PC) data acquisition system, D. The analog data were sampled, digitized, and analyzed on the PC. Item E was an auditory stimulator, electronically coupled to the data acquisition/analog-to-digital conversion, item D. A second PC (Unit E) provided the auditory signal to the subject via an audio speaker, unit F. All physiological data were amplified and analog filtered before analog-to-digital conversion by the PC. Event related brain potential (ERP) processing, averaging and analyses then followed. GSR (skin potential, SP) activity was recorded from the wrist area. Boucsein (1992) has provided a detailed discussion of electrodermal activity.

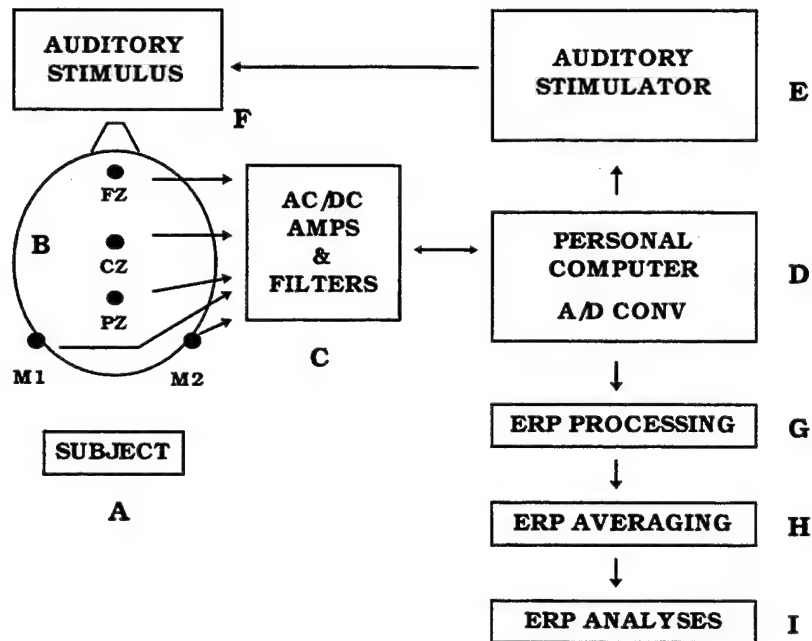


Figure 2. Schematic illustration of recording and processing approach.

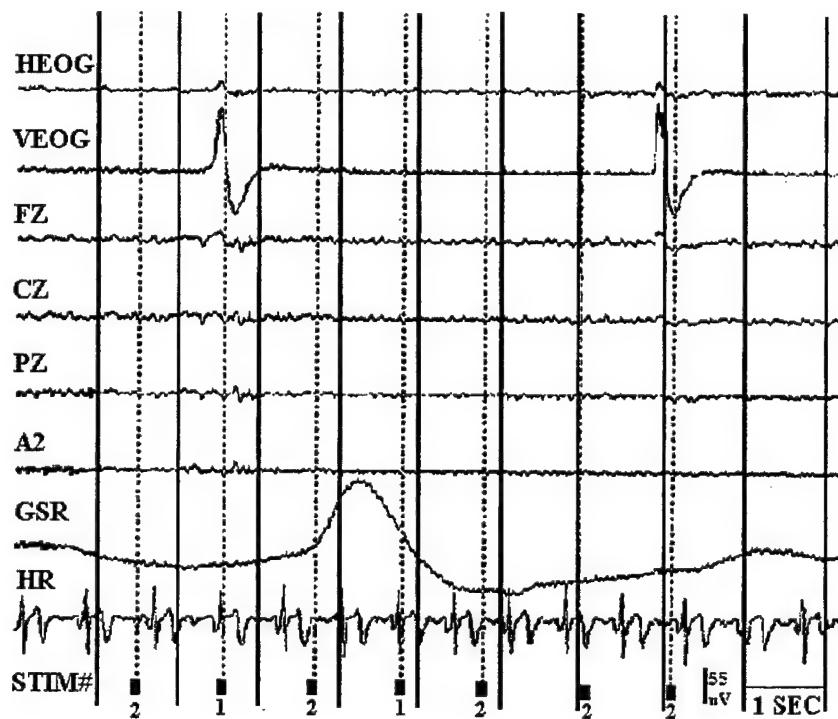


Figure 3. On-going eye movement, EEG, GSR, and HR activity.

All electrophysiological data were recorded in continuous mode for later off-line analyses. The cost of doing continuous recording is disk space and more steps during preprocessing and analyses. The sample record (Figure 3) shows a 10 second record obtained during the no video control segment. Nine data channels from top to bottom of the record represent data from horizontal electrooculogram (HEOG), vertical electrooculogram (VEOG), three cephalic EEG sites [frontal (FZ), central (CZ), parietal (PZ) on the sagittal line], linked mastoid references [M1-M2 (A2)], used for later digital re-referencing of the EEG channels, galvanic skin response (GSR), and heart rate (HR). Two eyeblinks may be seen in the VEOG channel with some of the artifact seen in the FZ channel as well. The auditory stimuli were represented as "1" and "2" near the bottom of Figure 3. Amplitude calibration (55uV) may be seen in the lower right corner. This record shows the eyeblink to have about 165 uV amplitude and the HR record to have about 110 uV amplitude.

Figure 3 was a hardcopy, which was scanned in and later digitally adapted and modified using Adobe Photoshop software.

### **Electrophysiological Preprocessing**

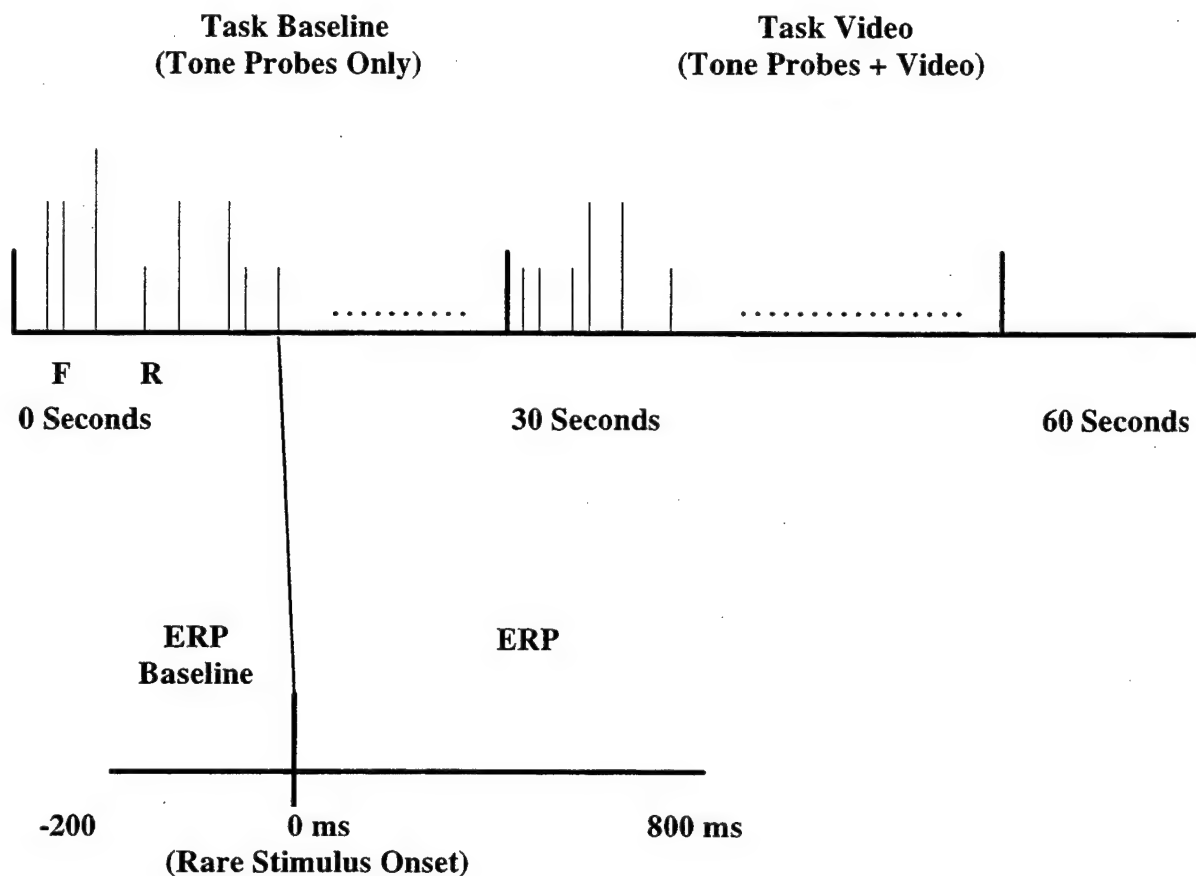
Several steps are required in the preprocessing of the electrophysiological data. The first step is to copy the original continuous data file for data security reasons. The scalp electrode sites must either have eyeblink and eye movement artifacts removed or the artifacts corrected. Data were preprocessed with both procedures. Using the correction algorithm procedure provides for the saving of many more data records. Once the data have been corrected for both vertical eye activity (eyeblinks) and horizontal eye movements, specific channels are then selected (FZ, CZ, PZ, A2) and digitally filtered. Both low-pass (10 Hz) and high-pass (1.0 Hz) filters had roll-off characteristics of 24 dB/octave. The continuous data are then epoched from 200 msec prestimulus (-200 msec) to 800 msec poststimulus. Stimulus information is preserved in the original continuous data file. Baseline correction was then performed, based on prestimulus activity from -100 msec to stimulus onset. The electrophysiological data were stored at each of these stages for security reasons, and also to allow for the going back and reanalyzing the data at specific stages if required.

Sorting of the epochs by stimulus condition was the next stage. Sorting by trial provided the baseline versus video segment comparisons, while sorting by type allowed examination of the "rare" versus "frequent" stimulus conditions. The desired spectral analyses, signal-to-noise ratio, variance, signal averaging, and other analytic procedures were then performed on the data. Only the "rare" stimuli epochs were used to construct the ERP averages in this report.

Figure 4 shows the relationships between behavioral task baseline, task video, and ERP timebases. During the task baseline, only tone probe stimuli were presented without video material. The frequent and rare tone probes were represented by the letters "F" and "R" respectively. This baseline recording period lasted for 30 seconds. The video presentation followed immediately after the no-video baseline period. During this period, the tone probes were presented while the video material was being viewed, and lasted 30 seconds. The relationship between the probe stimuli and the ERP waveform timebase also may be seen in Figure 4. The ERP records for this report were obtained from only the "rare" tone probe stimuli.



It may be seen that the prestimulus ERP baseline was 200 msec, while the poststimulus ERP waveform was 800 msec.



**Figure 4. Task and ERP waveform timebases.**

The irrelevant probes were used to synchronize brain activity processing before and during the video material presentation, and generate the event-related brain potentials. Different video material segments were randomized across subjects. Each subject viewed a blank TV monitor screen with no video material present for about 30 seconds. This was called the pre-video baseline condition. A total of 12 epochs from each subject were averaged to generate the pre-video baseline ERP waveforms.

### **Procedures**

Each subject was briefed prior to testing, and asked to read the Privacy Act Statement, sign the Consent Form, and fill in the Subject Data Sheet. Electrodes were then attached. The subjects were presented the auditory stimuli for baseline recording, followed by presentation of the experimental video material. Total testing time did not exceed one hour per subject. The time line was 5-10 minutes for the initial briefing, giving the Privacy Act and Consent Forms,

and answering questions by the subject; application of the helmet and electrodes was about 5-10 minutes. However, it took longer for some subjects than others to minimize the impedance between the scalp and electrodes. Total recording time was between 20 and 30 minutes. As noted earlier in this report, several video segments were presented to each subject. However only those data from the 30 second segment "Nose" was presented in this report. Removal of the helmet, minor cleanup, debriefing the subject, and answering questions from the subjects usually took the final 5-10 minutes. Approximate time requirements for the testing protocol were:

Activity	Time (Minutes)	Cumulative Time (Minutes)
Brief Subject	5	5
Forms	10	15
Privacy Act		
Consent		
Subject Data		
Attach Electrodes	10	25
Calibrate	5	30
Baseline Recording (Auditory Oddball)	5	35
Video Material (Auditory Oddball)	15	50
Baseline Recording (Auditory Oddball)	5	55
Remove Electrodes/Debrief	5	60

## Results

### Behavioral Data

Age, biographical, and video tape evaluation data were coded and correlation analyses were performed. Six of the seven video segment evaluations were analyzed. They included two 30 second commercials from the Partnership For a Drug Free America series (Nose and Housewife), two 120 second video segments from the PREVENT Course (Robin Williams and Up/Down), as well as the video controls for each grouping (Olympic runners for the 30-second commercials and Olympic divers and runners for the 120-second segments). Data from 26 subjects were analyzed. Age was found to be negatively correlated to wakefulness on the biographical questionnaire ( $r = -.49, p < .01$ ). A negative correlation was also found between age and interest within the Robin Williams segment only ( $r = -.43, p < .03$ ). The implication is that this segment may be of interest to only younger PREVENT students. Relationships between age and effectiveness was found to be reliable for the Up/Down segment ( $r = -.42, p < .03$ ), and between



age and information content only for this same segment ( $r = -.42, p < .03$ ). No statistically reliable relationships were found between age and realism for any of the video segments.

When interest and effectiveness were assessed within each video segment, all segments showed strong positive relationships, with the least being for the Robin Williams segment ( $r = .41, p < .04$ ) and the greatest for Up/Down ( $r = .91, p < .000$ ). Three other segments had correlations of .61 or better ( $p < .001$ ). When examining effectiveness and information content relationships, four of the six segments were statistically significant. These included the following segments: Robin Williams ( $r = .50, p < .01$ ); 120 second control ( $r = .61, p < .001$ ); Housewife ( $r = .68, p < .000$ ); and Up/Down ( $r = .75, p < .000$ ).

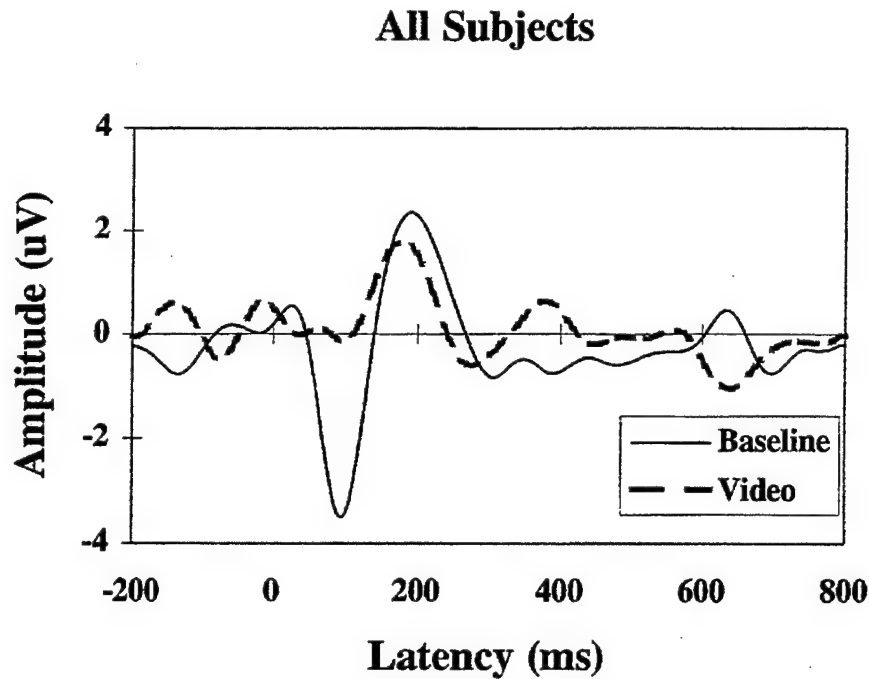
Four of six segments showed reliable relationships between alertness for the video segment and interest in that same segment. The strongest relationship was found for the 120 second control run ( $r = .60, p < .001$ ), followed by the 30 control run ( $r = .48, p < .013$ ), Housewife 30-second commercial ( $r = .44, p < .02$ ), and the Nose 30-second commercial ( $r = .42, p < .03$ ). No statistically reliable relationships were found for the Robin Williams nor Up/Down PREVENT segments.

### **Electrophysiological Data**

The electrophysiological data presented in this report will be limited to ERP results obtained from the 30 second baseline recordings prior to presenting the video material and during the video segment for the Partnership for a Drug Free America commercial titled "Nose." Even though ERP data were recorded from the frontal, central and parietal regions of the scalp, only graphic data from the frontal region will be presented in this report. ERP data for all subjects combined will be followed by ERP data from HIGH interest subjects, and finally ERP data from LOW interest subjects will be described.

#### **All Subjects Baseline Versus Video Comparisons**

Figure 5 shows an overlay of the grand average waveforms for the 30 second prevideo baseline (solid line) with the 30 second video segment (dashed line) at the frontal site (FZ). The component of interest in Figure 5 is negative at about 90 ms, and has been related to attentional factors in the literature. This component was statistically significant for the baseline versus video material comparisons ( $t = -2.78, p < .01, df = 24$ ). Data presented in Figure 5 demonstrates that the irrelevant probe procedure does discriminate the recording condition from the video material condition.



**Figure 5. ERP baseline versus video for all subjects.**

#### **HIGH Group Baseline Versus Video Comparisons**

Figure 6 shows an overlay of the HIGH group grand average waveforms for the 30 second prevideo baseline (solid line) with the 30 second video segment (dashed line) at the frontal site (FZ). The component of interest in Figure 6 was negative going at about 90-100 msec, and as noted before has been related to attentional factors in the literature. This component was statistically significant for the baseline versus video comparisons ( $t = -2.23, p < .025, df = 24$ ).

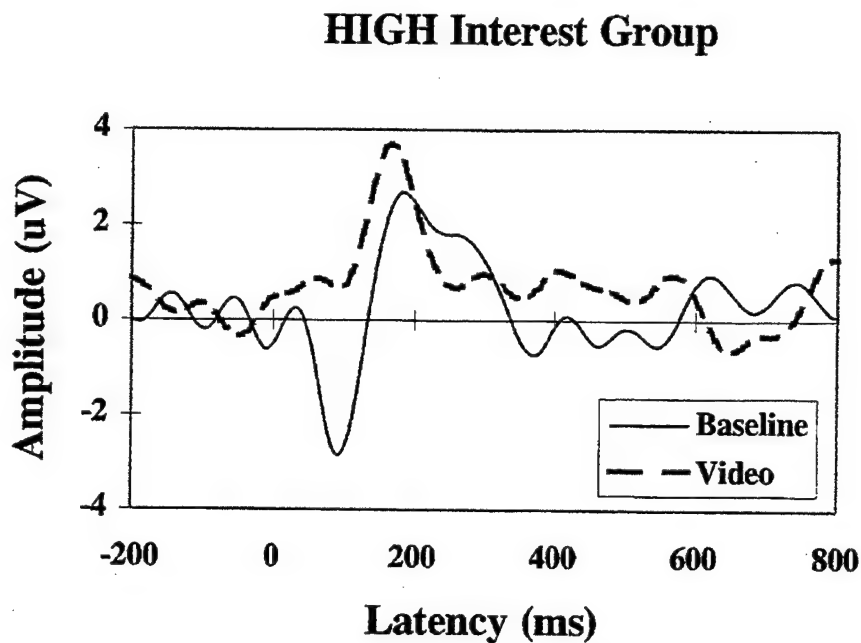


Figure 6. ERP baseline and video data for the HIGH interest group.

#### LOW Group Baseline/Video Comparisons

Figure 7 represents grouped ERP averages from the LOW interest group frontal sites.

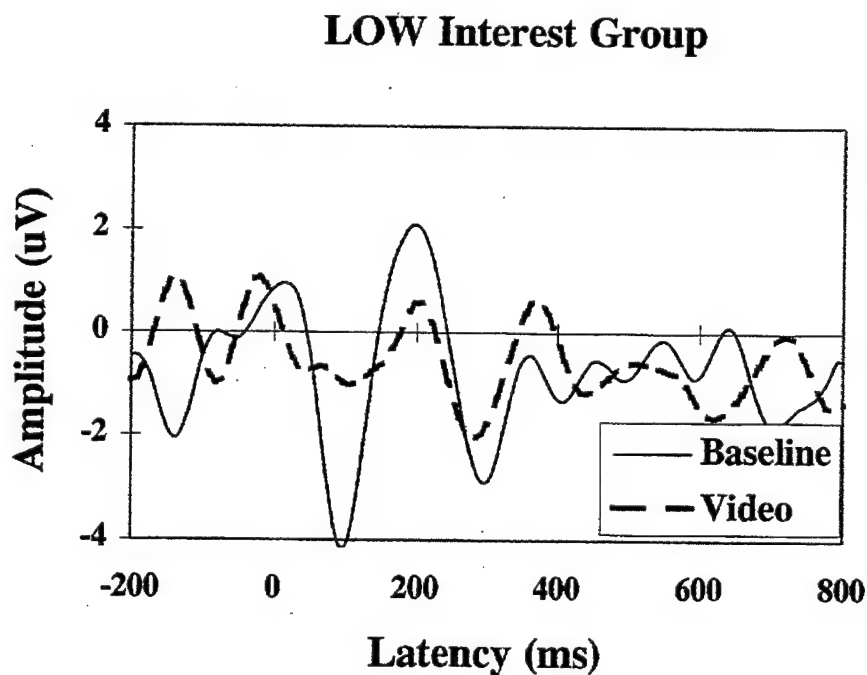
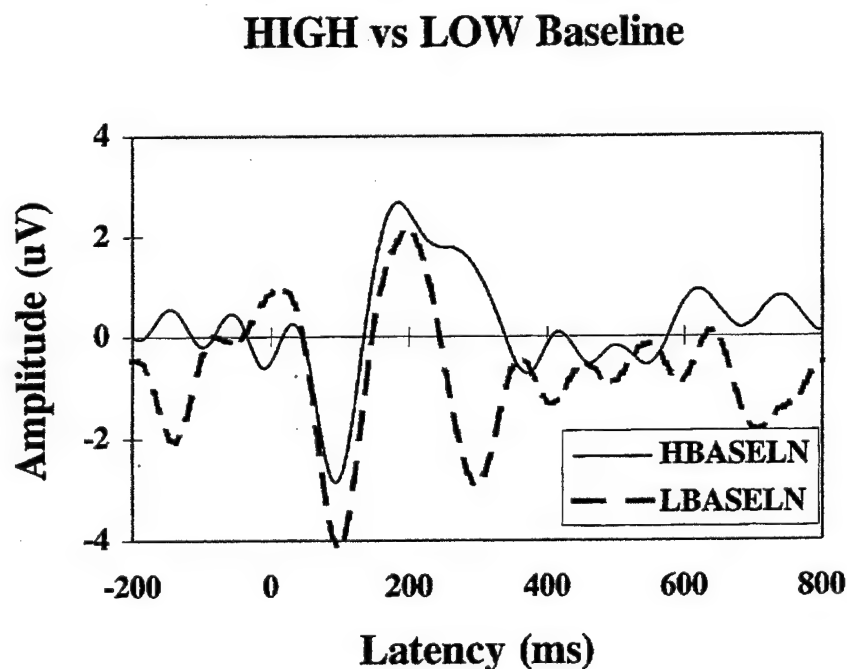


Figure 7. ERP baseline and video data for the LOW interest group.

The ERP component at about 90 ms was also statistically significant when the prevideo and video material comparisons were made for the LOW interest group ( $t = -1.78, p < .05, df = 24$ ). In Figures 6 and 7, the large N1 component (negative component at about 90 - 100 msec) was seen in the baseline condition, but decreased significantly for the waveform obtained while watching the video segment. Figures 6 and 7 show ERP waveforms for the HIGH interest and the LOW interest groups, respectively, when baseline and video material ERPs were compared.

### HIGH Versus LOW Group Baseline Comparisons

ERP data for the HIGH and LOW groups were compared across baseline conditions. The overlay of the ERP averages for the HIGH group baseline (solid line) with the LOW group baseline (dashed line) are shown in Figure 8. These data are the same data presented in Figures 6 and 7.



**Figure 8.** ERP baseline data for the HIGH and LOW interest groups.

From Figure 8, it may be seen that there were no statistically significant differences between the HIGH and LOW interest groups for the ERP components in the region of about 50 to 200 msec during baseline conditions.

### HIGH Versus LOW Group Video Comparisons

Figure 9 represents interesting comparisons for the current research. These comparisons reflect the sensory and cognitive processing differences of the two "interest" groups for the drug abuse prevention training material.

## HIGH vs LOW Video

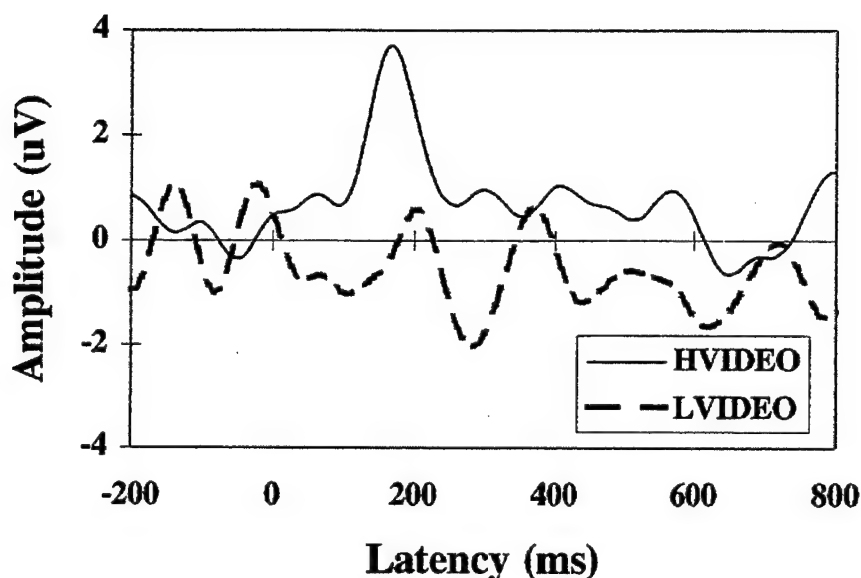


Figure 9. ERP video data for the HIGH and LOW interest groups.

Figure 9 shows that with the exception of the positive component at about 150 msec, the HIGH group (solid line) had much lower variability throughout the entire waveform than did the LOW group (dashed line). Statistically significant differences were noted between the HIGH and LOW interest groups for the component at about 150 msec ( $t = 2.59$ ,  $p < .01$ ,  $df = 24$ ). In addition, the overall waveform for the HIGH interest group was primarily positive voltage, while that for the LOW interest group was largely negative voltage.

## Discussion

The group criterion for the current research was interest and effectiveness of drug abuse training material. Behavioral responses about interest level in the training material were obtained from each of the subjects. This information was used to assign each subject to either the HIGH or LOW criterion group. The data presented in this report suggest that the concept of using auditory irrelevant probe stimuli, and the resulting auditory ERPs, may be used to assess levels of interest in training materials. Even though this initial report used verbal and behavioral data as criteria, in the future, such interest may be assessed without verbal or behavioral report.

For the HIGH interest group, (Figure 6) and the LOW interest group (Figure 7), the large N1 component (negative component at about 90 - 100 msec) may be seen in the baseline condition. However, this component decreased for both groups while watching the video segment. Such decrease noted at the FZ site agrees with the cortical topography literature where this component has been identified. Both groups were similar in showing a well defined negative ERP component at about 100 ms during the baseline condition. Statistically significant group differences were found between the baseline and video presentation conditions. These

differences were greater for the HIGH group than the LOW group. In addition, the HIGH interest group showed an ERP waveform which remained positive in voltage throughout the entire 800 msec poststimulus epoch. The LOW interest group, however, generally showed negative voltage throughout the 800 msec epoch length. This negativity may be related to "processing negativity," which has been shown to result when individuals show inattention to task materials.

Middle latency responses (MLR) of the auditory ERP have been studied for attentional relationships. The MLR is believed to be due to early activity at primary auditory cortex. The largest components are several positive peaks from about 20-50 ms. Enhancement of these positive peaks is seen when attention is directed to the stimuli (Woldorf & Hillyard, 1991). MLR positively correlates with N1 component amplitude. The N1 has multiple sources in auditory cortex. There may also be sources in motor and premotor cortex which may be related to an orienting response to deviant tones. The large positive component (P2) seen in the HIGH group data (Figures 6 & 9) may have multiple sources in auditory cortex. In many studies, N1 and P2 components covary, but are considered to be two distinct components. The N1-P2 effect has been investigated for many years. Generally, the N1-P2 amplitude is larger to attended stimuli than unattended stimuli and is generally reduced by drug and alcohol use. The N1-P2 component may be followed by a sustained negative late slow potential which is maximal in the frontal region. In some cases, this slow potential may attenuate the P2 component. It has been proposed that the slow potential may be generated in the auditory projection areas.

Amplitude of the N1 component is inversely proportional to the interstimulus interval, which is primarily due to refractory period rather than habituation. N1 amplitude to unattended stimuli, as found in the current research, is larger at higher levels of alertness. These data suggest that interest, attention and the higher-order processing of drug abuse prevention training material may be assessed through event-related brain potentials, using irrelevant probe stimuli. Such stimuli provide an unobtrusive and objective measure of information which may not be available through traditional behavioral assessment.

Results from this research were presented at the Annual Meeting of the Society For Neuroscience (Lewis & Ryan-Jones, 1995). In addition, this research was evaluated and qualified for submission as a patent application to the United States Patent and Trademark Office by the Office of Legal Counsel for Patents, Naval Command, Control and Ocean Surveillance Center, RDT&E Division, San Diego on 12 November 1996. The citation for this patent application is: Lewis, G. W. & Ryan-Jones, D. L. "Evaluation of a Subject's Interest in Education, Training and Other Materials Using Brain Activity Patterns," Navy Case No. 76514. The technology described in this pending patent has also been described in detail in Lewis and Ryan-Jones, Patent Number 5,325,862, titled, "Method and/or System for Personal Identification and Impairment Assessment From Brain Activity Patterns." Issued 5 July 1994.

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**Appendix A**  
**Privacy Act Statement**

**Navy Personnel Research and Development Center  
53335 Ryne Road  
San Diego, California 92152-7250**

**Privacy Act Statement**

**The Privacy Act of 1974 (Public Law 93-579) implements 5U.S.C.552A (Privacy Act of 1974) and DOD Directive 5400.11 (Personal Privacy and Rights of Individuals Regarding Their Personal Records) and is published in Title 32 C.F.R., Part 701, subparts F and G. This Act requires us to provide you with certain information about the research before we ask you to give us information about yourself. Following are the things you must be told:**

1. SECNAV Instruction 5211.5C, "Personal privacy and rights of individuals regarding records pertaining to themselves," is available for your review.
2. The title of this research project is: Electrophysiological Assessment of Drug Abuse Prevention Training.
3. The primary purpose of this study is to improve the Navy's methods of assessing drug abuse training materials.
4. Various kinds of personal information will be requested of you, which may include such things as your height and weight, where and when you were born, whether or not you smoke and/or chew tobacco, or whether or not you are taking prescription medicine.
5. Your Social Security number is needed to permit us to obtain test scores (e.g., ASVAB, and Reading Scores).
6. This information will be used for scientific research purposes only. It will not be given to anyone outside this Center, and it will not be used for anything besides scientific study. The information you give will not help or hurt you personally or professionally in any way during your tour with the Navy.
7. Your participation in this project is entirely voluntary. You are not required to give us any or all of this information if you do not want to, and nothing will happen to you if you decide you do not want to assist in this study.

**Appendix B**  
**Consent Form**

**Navy Personnel Research and Development Center  
53335 Ryne Road  
San Diego, California 92152-7250**

**Consent to Act as Subject for Scientific Research**

1. I \_\_\_\_\_ voluntarily agree to serve as a subject for scientific research which involves the following:

Recording my electroencephalogram (EEG, i.e. brain waves) for study. I understand that I may be asked to perform certain tasks while being tested, such as listening to certain sounds and watching video material related to drug abuse prevention training.

2. The procedure outline in paragraph (1) has been explained to me.

3. I understand that the procedure outlined in paragraph (1) may involve the following risks and discomforts:

There are no known risks in this procedure. Some discomfort is possible from having to sit relatively still for a period which ranges from 2 to 5 minutes. It may be necessary to wash a small amount of water soluble jelly from my hair.

4. I understand that this research will not benefit me directly. My participation in this project will increase scientific understanding of how the brain functions and help research on improving methods of assessing drug abuse prevention training materials. This research is intended to be of benefit to others and to the Navy Department.

5. I understand that any questions I may have during the experiment will be answered, and that I may end my participation in this study at any time.

6. I have read the attached Privacy Act Statement, and understand that giving information about myself is entirely voluntary, that this information will be kept confidential, and that the uses of that information will be only for scientific purposes.

\_\_\_\_\_  
Signature

\_\_\_\_\_  
Date

\_\_\_\_\_  
Witness Signature

\_\_\_\_\_  
Date



**Appendix C**  
**Subject Data Sheet**

**Navy Personnel Research and Development Center**  
**53335 Ryne Road**  
**San Diego, California 92152-7250**

**Subject Data Sheet**

Name \_\_\_\_\_  
Last, First Middle

SSN \_\_\_\_\_ Rank \_\_\_\_\_

Birth Date \_\_\_\_\_ Place \_\_\_\_\_

1. How do you feel right now?  
Tired \_\_\_\_\_ Drowsy \_\_\_\_\_ Awake \_\_\_\_\_ Alert \_\_\_\_\_
2. Do you speak and/or read any language beside English?  
Yes \_\_\_\_\_ No \_\_\_\_\_ If so, which? \_\_\_\_\_
3. Do you smoke and/or chew tobacco?  
Yes \_\_\_\_\_ No \_\_\_\_\_
4. Have you taken medication within the last 24 hours?  
Yes \_\_\_\_\_ No \_\_\_\_\_
5. Handedness  
Right \_\_\_\_\_ Left \_\_\_\_\_ Ambidextrous \_\_\_\_\_
6. Do you wear glasses/contacts?  
Yes \_\_\_\_\_ No \_\_\_\_\_
7. Do you have hearing difficulties?  
Yes \_\_\_\_\_ No \_\_\_\_\_ If so which ear? Right \_\_\_\_\_ Left \_\_\_\_\_

## **Appendix D**

### **Video Tape Questionnaire for all Subjects**

## Video Tape Material Evaluation

Subject Number \_\_\_\_\_ Segment \_\_\_\_\_

Please circle the numbers that describe your feelings about the video you just viewed.

1. Have you seen this segment before ?

Yes                  No

2. Interest

Very Boring                  Neutral                  Very Interesting  
1   2   3   4   5   6   7

3. Effectiveness

Very Ineffective                  Neutral                  Very Effective  
1   2   3   4   5   6   7

4. Information

Very Inaccurate                  Neutral                  Very Accurate  
1   2   3   4   5   6   7

5. Quality

(Subject matter, not magnetic tape itself)

Very Low Quality                  Neutral                  Very High Quality  
1   2   3   4   5   6   7

6. Main character(s)

Very Dislikable                  Neutral                  Very Likable  
1   2   3   4   5   6   7

7. Realism

Very Unrealistic                  Neutral                  Very Realistic  
1   2   3   4   5   6   7

8. Mood

Very Serious                  Neutral                  Very Lighthearted  
1   2   3   4   5   6   7

9. Alertness

Drowsy                  Awake                  Very Alert  
1   2   3   4   5   6   7

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